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(54) **Water soluble polymeric thickeners for products for topical application.**

(57) A thickener for products for topical application such as personal care products for application to the skin or hair, or topically administrable pharmaceutical preparations, comprises a water-in-oil emulsion containing polymeric material, at least 98% of which polymeric material is soluble in the aqueous phase. The polymeric material comprises units derived from (a) acrylamide, (b) 2-acrylamido-2-methyl-propane-sulphonic acid (AMPS) and (c) a polyfunctional monomer, present in an amount of from 0.12 to 2 milliequivalents per mol of total monomer units. At least some of the AMPS units are in the form of a neutral salt such that the aqueous phase of the water in oil emulsion has a pH of at least 5.5.

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This invention relates to water soluble polymer compositions specifically tailored for use as thickeners/stabilizers for products for topical application such as personal care products for application to the skin or hair, or topically administrable pharmaceutical preparations, where the formulated products are of an anionic or nonionic character.

Personal care products are those applied to the skin and/or hair, examples of which are moisturizers, cleansers, toners, barrier creams, shampoos, and styling and setting gels. Such products are usually formulated as creams (oil in water emulsions), or clear gels which may contain substantial quantities of water miscible alcohols or glycols. All use thickeners/stabilizers to modify rheological properties and to improve stability.

Conventionally both natural and synthetic materials have been used for this purpose. Natural products (eg gum arabic, guar gum or starches) vary in quality and hence performance. They also result in products of only a limited shelf life. Synthetic materials are more commonly used having a more consistent quality giving products of better stability. Currently used synthetics are all solids or powders of polymers having residual acid groups, which have to be dispersed or dissolved in water then neutralised before becoming effective. This is because the thickening capability of such compounds is pH dependent; they will not thicken until the acid groups have been neutralised. Great care is needed to prevent agglomeration and lump formation; hours of mixing may be needed before a stable dispersion is achieved.

A significant advantage for the personal care products and pharmaceuticals industry would be to provide a polymer composition which would serve both as a thickener and as a stabilizer and was also in liquid form to enable easy handling by automatic dispensers, metering pumps etc, and which is readily dispersible.

Surprisingly, we have found that it is possible, by the present invention and using the well known inverse polymerisation technique, to produce polymers that function as both thickeners and stabilizers. They are dispersible in seconds and fully effective without neutralisation, yet still conform to all other stringent conditions ideally required for these specific applications, ie:

1) Do not impede the fully formulated personal care or pharmaceutical product from meeting all statutory safety and toxicological requirements for use.

2) Are highly efficient, ie the maximum addition which would serve both as a thickener and stabilizer should represent ≦2.0%, preferably ≦1.5% and most preferably ≦1.0% (expressed as polymer solids) of the total composition. At room temperature, in de-ionized water at a concentration of 2% by weight, a viscosity equal to or greater than 30,000 mPa.s should be achieved. Viscosity is measured on a UK LVF viscometer spindle 4 speed 6.

3) Are effective thickeners and stabilizers and show minimal viscosity change over a wide pH range of about 4 to 14, especially 5 to 10 and most importantly 5 to 9. This is because personal care products preferably have a pH range of between 5 and 9.0, and most preferably between 5.5 and 7.5. Polymers useful in this invention when measured as a 1% (polymer solids) solution, in de-ionised water, have a pH ≧5.5 and most preferably ≧6.0 but ≦10.0.

4) Have an especially high content of water soluble polymer ie ≧98.0%, preferably ≧99.0% and most preferably ≧99.5%. The solubility assessment is made by vacuum filtering 2 litres of 0.1% aqueous thickener solution (expressed as polymer solids) through a 46 micron screen, washing the residue, then drying at 110°C to constant weight. This high solubility allows essentially all of the polymer to be dissolved in the liquid phase of the personal care or pharmaceutical product.

5) Once formulated the polymer remains water soluble so that it can easily be washed off the skin.

6) Molecular weight of the polymer should be high enough to prevent the polymer's absorption through the skin (say ≧ 500,000), but low enough to maintain high water solubility (say ≦ 10M, especially ≦ 5M). This is characterised by the polymer viscosity requirement in combination with the toxicological testing of the fully formulated product.

7) Are able to thicken and stabilize aqueous alcohol and/or glycol solutions.

8) Possess oil emulsification properties as oily substances are often used in cream formulations eg sweet almond oil, paraffin oil and cetearyl octanoate.

9) Be UV and temperature stable under all normal conditions of use; when considering barrier creams for skiers, this extends below 0°C. A suitable accelerated test at higher temperature would be stability of at least 1 month at 50°C in a fully formulated composition.

10) Formulated products should be smooth and free of lumpy or gritty components. They should be neither sticky nor adhesive in character.

According to a first aspect, the invention provides a water in oil emulsion containing polymeric material, in which at least 98% of the polymeric material in the emulsion is water soluble, and the polymeric material comprises units derived from (a) acrylamide (b) 2-acrylamido-2-methylpropanesulphonic acid (AMPS which is a registered trade mark of the Lubrizol Corp.), and (c) a polyfunctional monomer in an amount of from 0. 12 to 2 milliequivalents inclusive per mole of total monomer units, at least some of the AMPS units being in a neutral

salt form, such that the aqueous phase of the water in oil emulsion has a pH of at least 5. 5.

According to a second aspect, the invention provides a method of preparing a composition for topical application, which method comprises admixing a topically acceptable, liquid-containing, formulation containing a topically acceptable adjuvant with a water in oil emulsion as defined above. The formulation to which the water in oil, polymer containing, emulsion is added is preferably at least mainly liquid.

The invention additionally provides, according to a third aspect, a composition for topical application comprising

a topically acceptable liquid phase comprising an aqueous medium,

a polymeric material at least 98% of which is water soluble, which polymeric material comprises units derived from (a) acrylamide, (b) 2-acrylamido-2-methylpropanesulphonic acid and (c) a polyfunctional monomer, which polyfunctional monomer is present in an amount of from 0.12 to 2 milliequivalents inclusive per mole of total monomer units,

an oil phase,

a water in oil emulsifier,

an oil in water emulsifier, and

a topically acceptable adjuvant, optionally forming part of the liquid phase.

In particular, the invention provides a personal care product in which the topically acceptable liquid phase additionally comprises an aqueous alcohol and/or glycol solution, and also provides a pharmaceutical composition for topical application (which may additionally be a personal care product) in which the above composition for topical application contains additionally a pharmaceutically active component.

The water in oil emulsion may be prepared by a method, according to yet another aspect of the invention, which method comprises forming a water in oil emulsion of a monomer composition, in which the concentration of total monomer by weight of the total water in oil emulsion thereof is at least 30 weight % and which monomer composition comprises (a) acrylamide (b) AMPS and (c) a polyfunctional monomer in an amount of from 0.12 to 2 milliequivalents per mole of total monomer composition, at least some of the AMPS being in a neutral salt form, such that the aqueous phase of the water in oil emulsion has a pH of at least 5.5, and subjecting the monomer composition in the said emulsion to polymerisation.

The water in oil emulsion of the polymer can be obtained by the inverse emulsion polymerisation reaction of the neutralised salt of AMPS with acrylamide. They are reacted simultaneously with a small amount of the crosslinking agent to produce a partially crosslinked structure which is still water soluble. As the copolymers are derived from anionic and nonionic monomers they are compatible, and hence effective, in formulated systems of either anionic or nonionic character.

A similar combination of monomers, using N,N^1-methylene-bisacrylamide (MBA) as the crosslinker, is disclosed in GB-B-2007238. Although no method of determining water solubility is given, this combination is said to produce polymeric material which is a mixture of water insoluble (ie swellable) and water soluble polymers, at least 40% of which mixture is water insoluble. This mixture is chosen so as to provide improved rheological properties in the presence of electrolyte. However, such polymeric materials could not be formulated into a cream or gel of equivalent smoothness to that achievable using water soluble polymers of the present invention.

Polymers useful in the present invention can be manufactured by the processes disclosed in GB-B-2206125 and EP-B-0186361. These polymers remain dissolved in the aqueous phase of the inverse emulsion, both during and after polymerisation. In addition, the following conditions apply:

1) The crosslinking monomer must contain 2 or more sites of unsaturation and be sufficiently water soluble to react with aqueous acrylamide and neutralized or partially neutralised AMPS® monomers to produce a partially crosslinked copolymer that is still water soluble. The water solubility of the crosslinking agent is preferably at least 1% by weight of solution. Preferred cross linking agents are allyl sucrose, allyl pentaerythritol, and MBA. To retain solubility and to achieve optimum thickener/stabilizer efficiency, the molar ratio of crosslinking agent to the monomer mixture is critical; for MBA good results may be achieved within the range 0.06 to 1, preferably 0.08 to 0.7, the optimum being between 0.1 and 0.4 m.moles/mole, inclusive, of the monomer mixture. The precise quantity of crosslinking agent may be selected in dependence upon the proportion of AMPS in the monomer mix, larger proportions of AMPS possibly requiring slightly larger proportions of crosslinking agent.

2) The ratio, expressed as mole %, between the main monomers in the copolymer composition namely acrylamide/neutralized AMPS may be between 85/15 and 15/85, preferably between 70/30 and 30/70, more preferably between 65/35 and 35/65, especially between 60/40 and 40/60, inclusive.

3) Preferred neutralizing agents for AMPS are sodium or potassium hydroxide or water soluble/miscible amines of low toxicity (eg triethanolamine) or mixtures thereof.

4) Polymerisation may be carried out at a pH $\geqq$ 5.5, preferably $\geqq$ 6.0 and most preferably $\geqq$ 6.5, but $\leqq$ 10.0.

5) Oil in water emulsifiers or mixtures of emulsifiers, having an individual or composite HLB value $\geqq$10,

preferably ≧11 and most preferably ≧ 12 and other additives such as inverse emulsion stabilizers, wetting agents, antifoams or combinations or mixtures thereof may be added to the water-in-oil emulsion. In an especially preferred process an inverse monomer emulsion is formed before polymerisation, in which case the oil in water emulsifier and other additives are added after the emulsification of the disperse and continuous phases. However, they then may be added at any time before, during or after the polymerisation process. Preferably, at least some, more preferably all, of the oil in water emulsifier is added after the polymerisation process.

6) The polymer solids content of the water-in-oil emulsion incorporated into the personal care or pharmaceutical preparation is preferably 35-60%, more preferably 40-50% by weight of the total weight of the emulsion.

Compositions embodying the invention may be prepared by incorporating the water in oil emulsion into the remaining components, whereupon the emulsion "inverts" to provide a continuous liquid phase comprising the aqueous medium of the emulsion and any liquid in the composition comprising water or miscible with water. Preferably, essentially all of the polymer is dissolved in the liquid phase. Topically acceptable adjuvants such as the liquid carrier, for example, an alcohol and/or glycol, optionally mixed with water, will then form part of the continuous liquid phase, other topically acceptable adjuvants which are insoluble or only partially soluble in the liquid phase being present in suspension or emulsion. A typical personal care product may contain, by weight of the total composition, up to 50% inclusive of any alcohol or glycol and may contain up to 5%, especially 1-5% inclusive, of a surface active agent.

Using the method disclosed in Example 1 of EP-B-0186361, a series of polymers were prepared; their composition and properties are given in Table 1.

Experiments 1-7 inclusive, 10 and 12 in Table 1 show the thickening behaviour/solubility of polymer compositions similar to, but outside, the present invention. The thickening efficiency of polymers 1-6, which are homopolymers, is clearly inferior. Polymer 7, which is a copolymer, but contains sodium acrylate in place of the AMPS used in the compositions embodying the invention, meets the required standard of thickening efficiency (see Table 1). However, it gives an unstable solution viscosity over the preferred pH range 5.5 to 9 (see Graph 1). Polymers 10 and 12 contain too little and too much MBA respectively and neither meets the required standard of thickening efficiency (Table 1). As can be seen from Table 1 and Graph 1, only polymers 8, 9 and 11, embodying the present invention, meet the required standard of thickening efficiency (Table 1) and give a stable solution viscosity over the preferred pH range 5.5 to 9 (Graph 1).

A comparison between the same comonomer ratio and the degree of crosslinking can be seen in polymers 10, 11 and 12, in which the respective amounts of MBA in m moles per mole (and ppm by weight) of total monomer mix are 0.05m moles (50ppm), 0.22m moles (248ppm) and 1.1m moles (1240ppm). This comparison indicates that in order to thicken efficiently and retain solubility, the desirable level of MBA addition is above 0.05 and below 1.10 m.moles inclusive per mole of monomer mixture.

It is highly surprising that by controlling the amount of crosslinking agent between the range 0.12 to 2 milliequivalents per mole of total monomer units, an excellent thickening effect can be achieved without unwanted solids being present in the formulation and without incurring a "sticky" sensation to the skin on application, which occurs when too low a proportion of crosslinking agent is present.

Table 1

Polymer Composition	Cross-linking m.moles (m.equivs) MBA per mole of monomer mix	Viscosity 0.85% Polymer Solution (Brookfield LVF Spindle 4, Speed 6) mPa.s	% Insoluble Material in the Polymer
1. Sodium Polyacrylate	Zero (zero)	14,900	<0.1
2. Sodium Polyacrylate	0.22 (0.44)	22,000	<0.1
3. Homopolymer of Acrylamide	Zero (zero)	<1,000	<0.1
4. Homopolymer of Acrylamide	0.22 (0.44)	<1,000	<3.0
5. Homopolymer of Sodium Salt of AMPS	Zero (zero)	1,700	<0.1
6. Homopolymer of Sodium Salt of AMPS	0.22 (0.44)	13,300	<0.1
7. Copolymer of 50 mole% Acrylamide 50 mole% Sodium Acrylate	0.22 (0.44)	53,000	<0.1
8. Copolymer of 75 mole% Sodium Salt of AMPS 25 mole% Acrylamide	0.22 (0.44)	33,000	<0.1
9. Copolymer of 25 mole% Sodium Salt of AMPS 75 mole% Acrylamide	0.22 (0.44)	65,000	<0.5
10. Copolymer of 40 mole% Sodium Salt of AMPS 60 mole% Acrylamide	0.05 (0.10)	18,000	<0.01
11. Copolymer of 40 mole% Sodium Salt of AMPS 60 mole% Acrylamide	0.22 (0.44)	76,000	<0.01
12. Copolymer of 40 mole% Sodium Salt of AMPS 60 mole% Acrylamide	1.1 (2.2)	10,000	<0.5

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Polymer 11 of Table 1 corresponds to the copolymer described in Example 1. All viscosity and pH measurements mentioned in the examples were carried out at 25°C.

Example 1: BEST METHOD OF PREPARATION

Using the method described in Example 1 of EP-B-0186361 with an ammonium persulphate/sodium metabisulphite redox system a water in oil inverse emulsion was prepared from the sodium salt of 2-acrylamido-2-methylpropanesulphonic acid and acrylamide, crosslinked with N,N^1-methylenebisacrylamide. Polymer composition was 60 mole % acrylamide, 40 mole % sodium salt of AMPS, crosslinked with 0.22m.moles of MBA per mole monomer mixture. The polymerisation was carried out at pH 7.0. To the finished inverse emulsion was added 5% (based on the weight of the total inverse emulsion) of a mixture consisting 20% by weight of an antifoam and 80% by weight of an ethoxylated higher alcohol surfactant having an HLB of 12.5.

The finished inverse emulsion had the following properties:

1.	Polymer content	41%
2.	Inverse emulsion viscosity	3,200 mPa.s
3.	Inverse emulsion pH	6.9
4.	0.85% Polymer solution viscosity in deionised water	76,000 mPa.s
5.	pH of 1.0% solution	7.3
6.	% insoluble material	<0.01

USE EXAMPLES

The inverse emulsion from Example 1 was used for the following thickening experiments.

A. EXAMPLES OF PERSONAL CARE PRODUCTS

1. Thickening of water alcohol mixtures (necessary for preparation of personal care gels).

[a]	1.2% Polymer solution viscosity in deionised water	100,000mPa.s
[b]	1.2% Polymer solution viscosity in; 80% Water 20% Ethanol (90°)	100,000mPa.s
[c]	1.2% Polymer solution viscosity in; 50% Water 50% Ethanol (90°)	100,000mPa.s

2. Thickening of water glycol mixtures

[a]	1.2% Polymer solution viscosity in deionised water	100,000 mPa.s
	1.2% Polymer solution viscosity in; 70% Water 30% Propylene glycol	100,000mPa.s

3. Emulsion stabilisation (necessary for the preparation of personal care cream)

Formulation:

		Parts by weight
1.	Water	86.5
2.	Inverse emulsion from Example 1	3.0 (Polymer 1.23)
3.	Sepicide C1	0.2
4.	Sepicide HB	0.3
5.	Oil	10.0

Procedure:

Mixed items 2, 3 and 4 in item 1, using a high speed mixer then mixed item 5.

RESULTS:

Oil	Dimethicone	Sweet Almond Oil	Cetearyl Octanoate
Initial viscosity	>100,000mPa.s	>100,000mPa.s	>100,000mPa.s
1 month @ room temp.	stable	stable	stable
1 month @ 50°C	stable	stable	stable

4. Preparation of an after-shave lotion:

	Parts by weight
Water	82.80
Inverse emulsion from Example 1	1.50 (Polymer 0.62)
Ethanol 95°	10.00
Micropearl M 100 (Polymethyl methacrylate powder)	5.00
Sepicide C1 (Preservative)	0.50
Scala 5610 (Perfume)	0.20

Procedure:

Homogenised all ingredients with a higher shear mixer.

Properties/Characteristics:

Appearance	Smooth white gel/emulsion
pH	6.5
Viscosity	12,000 mPa.s
Stability	Stable at room temp. and at 50°C for more than four weeks.

5. Preparation of oil in water cream

		Parts by weight
1.	Simulsol 165 (self-emulsifying base for creams)	5.00
2.	Lanol 1688 (non-greasy ester)	20.00
3.	Lanol P (stabilizer)	1.00
4.	Water	71.00
5.	Inverse emulsion from Example 1	2.50 (Polymer 1.03)
6.	Sepicide HB (Preservative)	0.30
7.	Sepicide C1 (Preservative)	0.20

Procedure:

Heated items 1, 2 and 3 to 70°C and mixed in item 4, preheated to 75°C, using a high speed mixer. Cooled to 55°C and incorporated item 5 using the high speed mixer. Cooled to 45°C and incorporated items 6 and 7 using the high speed mixer.

Properties Characteristics:

Appearance	Smooth ivory coloured cream
pH	6.0
Viscosity	100,000mpa.s
Stability	Stable at room temp. and at 50°C for more than four weeks.

6. Preparation of Massage Gel

		Parts by weight
1.	Inverse emulsion from Example 1	3.50 (Polymer 1.44)
2.	Water	20.00
3.	Blue 512/12 (1%) (Colorant; 2 drops/100g)	
4.	Water	61.40
5.	Menthol	0.10
6.	Ethanol 95°	10.00
7.	Silicone oil (350 CS)	5.00

Procedure:

Using a high speed mixer, mixed item 1 in item 2 and followed by mixing items 3 dissolved in item 4 and item 5 dissolved in item 6. Then mixed in item 7.

Properties/Characteristics

Appearance	Smooth blue coloured transluscent gel
pH	5.5
Viscosity	100,000 mPa.s
Stability	Stable at room temp. and at 50°C for more than four weeks

B. EXAMPLES OF PHARMACEUTICAL PREPARATIONS

7. Preparation of Rubefacient Gel

		Parts by weight
1.	Water	62.00
2.	Inverse emulsion from Example 1	2.00 (Polymer 0.82)
3.	Methyl Nicotinate	0.50
4.	Sepicide CI	0.20
5.	Glycol Salicylate	10.00
6.	Ethanol 95°	25.00
7.	Sepicide HB	0.30

Procedure:

Dissolved items 3 and 4 in item 1 and mixed in item 2 with a high speed stirrer. Mixed items 5, 6 and 7 together and then added to stirring mixture of item 1-4.

Characteristics:

pH	about 5.5
Viscosity	about 11,000mPa.s
Appearance	White gel

8. Preparation of Keratosic Skin Treatment Cream

1.	Montanol 68 Hazelnut oil (cetearyl glucoside)	5.00	
2.	Wheat germ oil	3.00	
3.	Paraffin oil	7.00	
4.	Shea Tree Butter	1.00	
5.	Lipacid PCO (palmitoyl hydrolysed collagen)	2.00	
6.	Water	69.50	
7.	Inverse emulsion from Example 1	1.00	(Polymer 0.41)
8.	Sepicide CI	0.20	
9.	Sepicide HB	0.30	
10.	Urea	10.00	
11.	Ammonium Chloride	1.00	
12.	Perfume		
13.	Triethanolamine to pH 5.0		

Procedure:

Melted and dissolved items 1-5 at 70°C. Emulsified items 1-5 in 6 at 70°C. Mixed in item 7 at 60°C with high speed stirring. At 30°C mixed in items 8-12 with stirring. Adjusted the pH with item 13.

Characteristics:

pH	5.0
Viscosity	about 40,000 mPa.s
Appearance	Beige Cream

9. Preparation of Antibiotic Gel

		Parts by weight
1.	Water	79.5
2.	Sepicide CI	0.20

3.	Inverse emulsion from Example 1	3.00 (Polymer 1.23)
4.	Sepicide HB	0.30
5.	Erythromycin	2.00
6.	Ethanol 95°	15.00

Procedure:

Mix items 1 and 2 and add item 3 with high speed stirring. Add item 4 and 5 dissolved in 6 with high speed stirring.

Characteristics:

pH	about 9.1
Viscosity	about 75,000 mPa.s
Appearance	White gel

10. Preparation of Anti-Acne Gel

		Parts by weight
1.	Water	66.475
2.	Sepicide CI	0.2
3.	Inverse emulsion from Example 1	3.00 (Polymer 1.23)
4.	Retinoic Acid	0.025
5.	Sepicide HB	0.30
6.	Ethanol 95°	30.00

Procedure:

Mix items 1, 2 and 3 with high speed stirring. Add items 4 and 5 dissolved in 6 with high speed stirring.

Characteristics:

pH	about 6.8
Viscosity	about 85,000 mPa.s
Appearance	Yellow opaque gel

SEPICIDE - Registered Trade Mark of SEPPIC - Paris
MICROPEARL - Registered Trade Mark of MATSUMOTO - Japan
SIMULSOL - Registered Trade Mark of SEPPIC - Paris
LANOL - Registered Trade Mark of SEPPIC - Paris
COLORANT 512/12, supplied by WACKER - France
Perfume Scala 5610, supplied by PFIZER - USA
MONTANOL - Trade Mark of SEPPIC - Paris
LIPACID PCO - Trade Mark of GIRAUDAN - France

Claims

1. A method of preparing a composition for topical application, which method comprises admixing a topically acceptable, liquid-containing, formulation containing a topically acceptable adjuvant with a water in oil emulsion containing polymeric material, at least 98% of the polymeric material in the emulsion being water soluble, which polymeric material comprises units derived from (a) acrylamide, (b) 2-acrylamido-2-methylpropanesulphonic acid and (c) a polyfunctional monomer, which polyfunctional monomer is present in an amount of from 0.12 to 2 milliequivalents inclusive per mole of total monomer units, at least some of the 2-acrylamido-2-methylpropanesulphonic acid units being in the form of a neutral salt thereof such that the aqueous phase of the water in oil emulsion has a pH of at least 5.5.

2. A method according to claim 1, wherein the water in oil emulsion has a polymer content and a pH at which at least 98% of the polymeric material is dissolved in the aqueous phase of the water in oil emulsion.

3. A method according to claim 1 or claim 2, in which the polyfunctional monomer (c) in the water in oil emulsion is selected from at least one of allyl sucrose, allyl pentaerythritol and methylene-bisacrylamide.

4. A method according to claim 3, wherein the polyfunctional monomer is methylene-bisacrylamide.

5. A method according to claim 4, wherein the methylene-bisacrylamide is present in the water in oil emulsion in an amount of from 0.08 to 0.7 m.mole per 1 mole of the total of the monomer units (a) and (b).

6. A method according to claim 5, wherein the methylene- bisacrylamide is present in the water in oil emulsion in an amount of from 0.1 to 0.4 m.mole per 1 mole of the total of the monomer units (a) and (b).

7. A method according to any preceding claim in which the monomer units (a) and (b) are present in the water in oil emulsion in a molar ratio (a)/(b) of from 85/15 to 15/85 inclusive.

8. A method according to any preceding claim, wherein the water in oil emulsion contains, as a neutralizing agent, at least one of sodium and potassium hydroxides and water soluble and water miscible amines.

9. A method according to any preceding claim, wherein the composition for topical application additionally contains an oil in water emulsifying agent comprising at least one emulsifier and having a hydrophile lipophile balance of at least 10.

10. A method according to any preceding claim, wherein the topically acceptable adjuvant comprises an alcohol and/or glycol.

11. A method according to any preceding claim, which includes the preliminary step of preparing the water in oil emulsion containing the polymeric material, at least 98% of the polymeric material in the emulsion being water soluble, which preliminary step comprises forming, with the assistance of a water in oil emulsifier, a water in oil emulsion of a monomer composition, in which water in oil emulsion the concentration of total monomer, by weight of the total of the water in oil emulsion and monomer composition, is at least 30 weight % and which monomer composition comprises (a) acrylamide, (b) 2-acrylamido-2-methylpropanesulphonic acid and (c) a polyfunctional monomer, which polyfunctional monomer is present in the monomer composition in an amount of 0.12 to 2 milliequivalents inclusive per mole of total monomer units, at least some of the 2-acrylamido-2-methylpropanesulphonic acid being in the form of a neutral salt thereof such that the aqueous phase of the water in oil emulsion containing the monomer composition has a pH of at least 5.5, and subjecting the monomer composition to inverse emulsion polymerisation.

12. A composition for topical application comprising a topically acceptable liquid phase comprising an aqueous medium,

    a polymeric material at least 98% of which is water soluble, which polymeric material comprises units derived from (a) acrylamide, (b) 2-acrylamido-2-methylpropanesulphonic acid and (c) a polyfunctional monomer, which polyfunctional monomer is present in an amount of from 0.12 to 2 milliequivalents inclusive per mole of total monomer units,

    an oil phase,

a water in oil emulsifier,
an oil in water emulsifier, and
a topically acceptable adjuvant, optionally forming part of the liquid phase.

13. A personal care product which is a composition according to claim 12, wherein the topically acceptable liquid phase additionally comprises an alcohol and/or a glycol.

14. A pharmaceutical composition for topical application which is a composition according to claim 12, which additionally contains a pharmaceutically active component.

15. A composition according to any one of claims 12 to 14 which has a pH of at least 5.

16. A composition according to any one of claims 12 to 15 which is a cream.

17. A composition according to any one of claims 12 to 15 which is a gel.

18. A water in oil emulsion containing polymeric material, at least 98% of the polymeric material in the emulsion being water soluble, which polymeric material comprises units derived from (a) acrylamide, (b) 2-acrylamido-2-methyl-propanesulphonic acid and (c) a polyfunctional monomer, which polyfunctional monomer is present in an amount of from 0.12 to 2 milliequivalents inclusive per mole of total monomer units, at least some of the 2-acrylamido-2-methylpropanesulphonic acid units being in the form of a neutral salt thereof such that the aqueous phase of the water in oil emulsion has a pH of at least 5.5.

19. A water in oil emulsion according to claim 18, which has a polymer content and a pH at which at least 98% of the polymeric material is dissolved in the aqueous phase.

20. A water in oil emulsion according to claim 18 or 19, in which the polyfunctional monomer (c) in the water in oil emulsion is selected from at least one of allyl sucrose, allyl pentaerythritol and methylene-bisacrylamide.

21. A water in oil emulsion according to claim 20, wherein the polyfunctional monomer is methylene-bis-acrylamide.

22. A water in oil emulsion according to claim 21, wherein the methylene-bisacrylamide is present in the water in oil emulsion in an amount of from 0.06 to 1 m.mole per 1 mole of the total of the monomer units (a) and (b).

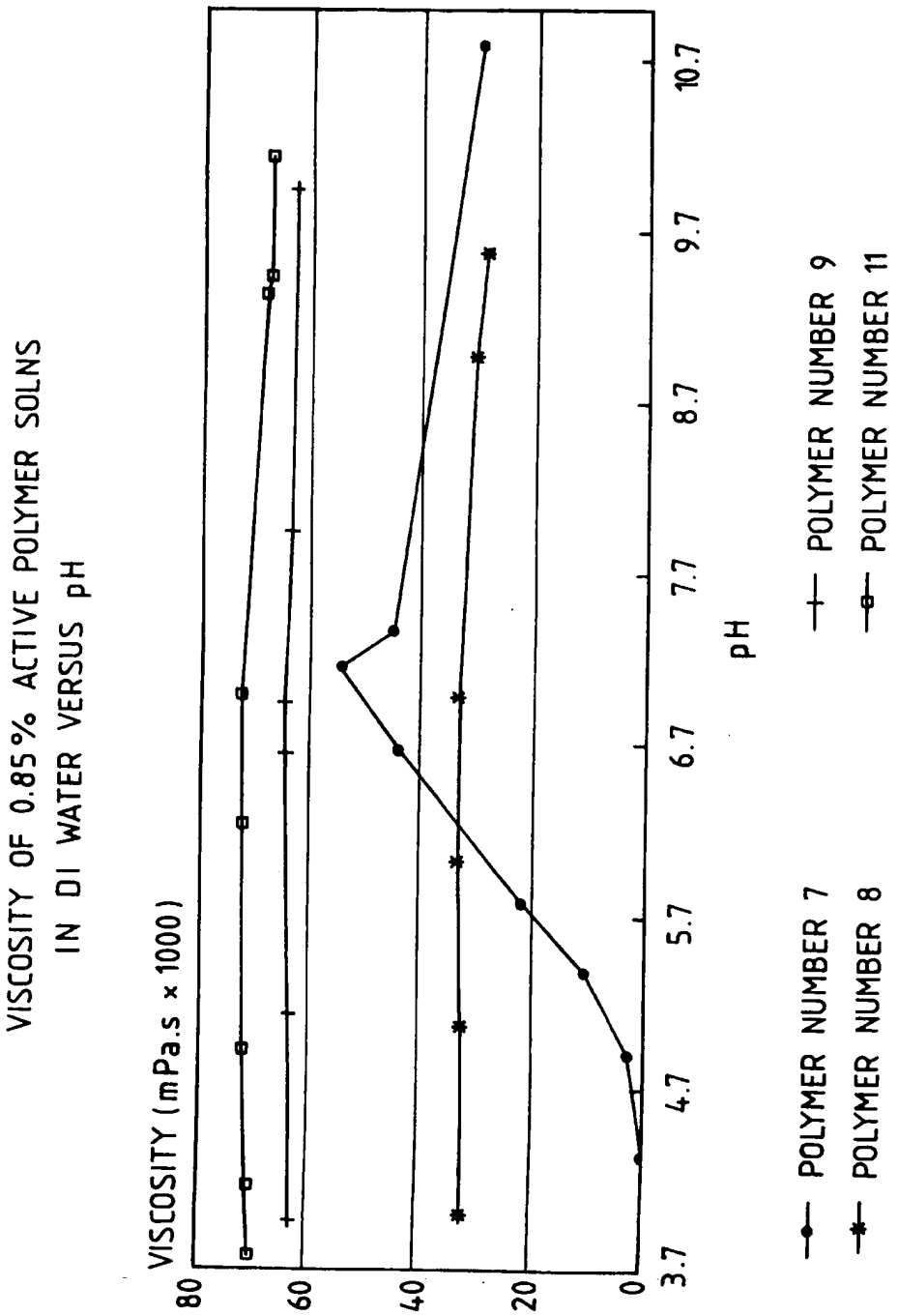
23. A water in oil emulsion according to claim 22, wherein the methylene-bisacrylamide is present in the water in oil emulsion in an amount of from 0.1 to 0.4 mole per 1 mole of the total of the monomer units (a) and (b).

24. A water in oil emulsion according to any one of claims 18 to 23, in which the monomer units (a) and (b) are present in a molar ratio (a)/(b) of from 85/15 to 15/85 inclusive.

25. A water in oil emulsion according to any one of claims 18 to 24, containing, as a neutralizing agent, at least one of sodium and potassium hydroxides and water soluble and water miscible amines.

26. A water in oil emulsion according to any one of claims 18 to 25, which additionally contains an oil in water emulsifying agent comprising at least one emulsifier and having a hydrophile lipophile balance of at least 10.

27. A method of preparing a water in oil emulsion containing polymeric material, at least 98% of the polymeric material in the emulsion being water soluble, which process comprises forming a water in oil emulsion of a monomer composition, in which water in oil emulsion the concentration of total monomer, by weight of the total of the water in oil emulsion and monomer composition, is at least 30 weight % and which monomer composition comprises (a) acrylamide, (b) 2-acrylamido-2-methylpropanesulphonic acid and (c) a polyfunctional monomer, which polyfunctional monomer is present in the monomer composition in an amount of 0.12 to 2 milliequivalents inclusive per mole of total monomer units, at least some of the 2-acrylamido-2-methylpropanesulphonic acid being in the form of a neutral salt thereof such that the aqueous phase of the water in oil emulsion containing the monomer composition has a pH of at least 5.5, and subjecting the monomer composition to inverse emulsion polymerisation.


VISCOSITY OF 0.85% ACTIVE POLYMER SOLNS
IN DI WATER VERSUS pH
VISCOSITY (mPa.s x 1000)
80
60
40
20
0
3.7
4.7
5.7
6.7
7.7
8.7
9.7
10.7
pH
POLYMER NUMBER 7
POLYMER NUMBER 8
POLYMER NUMBER 9
POLYMER NUMBER 11